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# ANALYSIS OF COMPOSITE MATERIALS FOR SINGLE POINT CUTTING TOOL

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## ABSTRACT

The main purpose of the structural design is to restrict the vibration of structures at a desirable level as per requirements. Usually, structures inherently possess low structural damping necessitating the introduction of additional measures to improve their damping characteristics in order to control the harmful effects of vibration in normal operating conditions. Since many decades, it has been a biggest challenge to the practicing engineers and designers to limit this unwanted vibration in structures. The sole contribution of the present investigation is intended in this direction only.

This project consists of an experimental work with a specific composite material using oil palm reinforced poly propylene and CFRP (Carbon Fibers Reinforced Polymer). The experimental results are compared with the corresponding theoretical ones. Composite materials exhibit good mechanical properties such as high stiffness and damping ratio at a lesser weight, compared to conventional materials. In this study, the mechanical characteristics of an oil palm reinforced fiber are studied against the conventional materials such as cast iron and steel with reference to constant stiffness. It is observed that, for same stiffness, the composite structure offers a considerable weight reduction, along with high damping characteristics.

**KEYWORDS:** Composite, CFRP, oil palm reinforced fiber, damping, vibration, weight reduction, cutting tool.

## INTRODUCTION:

Much emphasis has been placed upon vibrations in cutting tools during recent years because many people have recognized that accuracy, surface finish and, last but not least, production costs are considerably influenced by them. Today an arsenal of sophisticated instruments is available for the investigation of cutting tool vibration. However, in the final analysis, the finished surface itself will reflect the dynamic behavior of the cutting tool.

Cutting tools have always vibrated and will continue to do so. West rive to control these vibrations and keep them at or below a tolerable level. This was easier to do in the past than it is today. The older cutting tools had fewer auxiliary mechanisms, lower speed and feed ranges, and wide sliding ways which provided plenty of friction and also acted as vibration dampers. Newer cutting tools often have sliding ways which have been designed for reduced friction in order to keep servo-mechanisms small in size. Some friction dampening effects of metal to metal sliders have been eliminated because of the introduction of many anti-friction bearing design features. While higher cutting speeds generally contribute to an improvement of the surface finish obtained, they often excite Components of the cutting tool at their natural frequency. Such resonance conditions can usually be avoided by changing the spindle speed. If the cutting tool were infinitely stiff, it would be possible to predict surface finishes and accuracy of rigid work pieces.

Structural materials used in a cutting tool have a decisive role in determining the productivity and accuracy of the part manufactured in it. The conventional structural materials used in precision cutting tools such as cast iron and steel at high operating speeds develop positional errors due to the vibrations transferred into the structure. Studies carried out by researchers to build stiff structures by increasing the outer wall thickness for conventional materials indicates an improvement in stiffness, but not matching with the increased mass of the structure. Hence an alternative material which possesses good damping and stiffness has to be developed as structural materials.

### 1.1 Cutting Tools:

A cutting tool is a tool for machining metal or other rigid materials, usually by cutting, boring or other forms of deformation. Cutting tools employ some sort of tool that does the cutting or shaping. All cutting tools have some means of constraining the work piece and provide a guided movement of the parts of the machine. Thus the relative movement between the work piece and the cutting tool (which is called the tool path) is controlled or constrained by the machine to at least some extent, rather than being entirely "offhand" or "freehand". With the demand of high speed and high precision machining, cutting tools are being designed and manufactured with high dynamic performance in positioning accuracy and cutting stability.

### 1.2 Types of Cutting Tools:

A Cutting tool may be used for cutting apart, as with a knife, or for removing chips. Parts are produced by removing metal mostly in the form of small chips Chip removal in the metal-cutting process may be performed either by cutting tools having distinct cutting edge or by abrasive used in grinding wheels, abrasive sticks, abrasive cloth, etc. These abrasives have a very large number of hard grains with sharp edges which remove metal from the work piece surface in such operating as grinding.

All cutting tools can be divided into two groups. These are:
1. single-point tools. 2. Multi-point tools.

Single-point cutting tools having a wedge-like action find a wide application on lathe, and slotting machines. Multi-point cutting tools are merely two or more single-point tools arranged together as a unit. The milling cutter and broaching tool are good example of this type.

The simplest form of cutting tool is the single-point tool. The cutting process as performed by multi-point tools closely resembles machining as performed by single-point tools.

### 1.3 Type of Cutting Tool Materials:

The selection of proper tool material depends on the type of service to which the tool will be subjected. No material is superior in all respects, but rather each has certain characteristics which limit its field of application. The principal cutting materials are:

1. Carbon steels
2. Medium alloy steels
3. High-speed steels
4. Satellites
5. Cemented carbides
6. Ceramics
7. Diamonds
8. Abrasives

### 1.4 Vibration Control in Cutting Tools:

The vibration behavior of a cutting tool can be improved by a reduction of the intensity of the sources of vibration, by enhancement of the effective static stiffness and damping for the modes of vibration which result in relative displacements between tool and work piece, and by appropriate choice of cutting regimes, tool design, and work piece design. Abatement of the sources is important mainly for forced vibrations. Stiffness and damping are important for both forced and self-excited (chatter) vibrations. Both parameters, especially stiffness, are critical for accuracy of cutting tools, stiffness by reducing structural deformations from the cutting forces, and damping by accelerating the decay of transient vibrations. In addition, the application of vibration dampers and absorbers is an effective technique for the solution of machine-vibration problems. Such devices should be considered as a functional part of a machine, not as an add-on to solve specific problems.

**Sources and Causes of Vibrations in Cutting Tools:**
The vibrations that occur in the machining of metals are ordinarily of two types. Forced vibrations are those which occur under the action of a periodically varying force on the cutting tool arising out of mechanical causes. The frequency of such vibration depends upon the frequency of force variations at the source, which may be quite different from the natural frequencies of the vibrating members and self excited vibrations are those which occur because of dynamic instability of the vibrating member as shown in the figure 1.

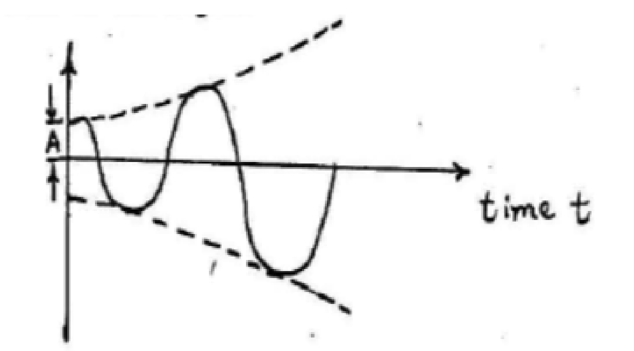


**Fig 1: Natural frequency of vibrating tool**

And once started by some mechanical means they are then self perpetuating. Self excited vibrations, as stated earlier, occur at a frequency very close to the natural frequency of the vibrating member. Of the two types of vibrations, the self excited type is ordinarily the more severe and gives most of the trouble.

**Damping:**
Term damping refers to the energy dissipation properties of a material or a system under cyclic stress but excludes energy transfer device. When a structure is subjected to an excitation by an external force then it vibrates in certain amplitude of vibration, it reduces as the external force is removed. This is due to some resistance offered to the structural member which may be internal or external. This resistance is termed as damping.

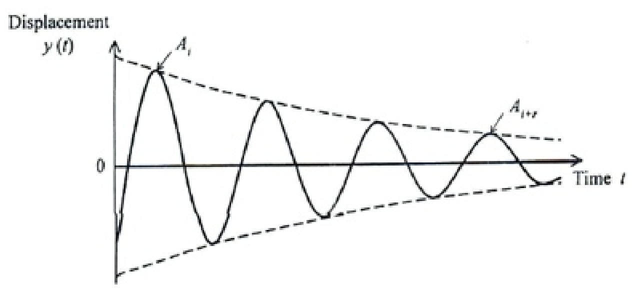


**Fig 2: Damping of vibrating tool**

**Cutting Speed:**
Cutting speed has the greatest influence on tool life. As the cutting speed increases the temperature also rises. The heat is more concentrated on the tool than on the work and the hardness of the work. The criterion of wear is dependent on cutting speed.

The relation of the cutting speed to the tool life is expressed by the formula:

**V Tn = C**

Where,
V= cutting speed in m per min.

T= Tool life in minutes.

n = exponent which depends on the tool and the work piece.

C= constant which is numerically equal to cutting speed that gives a tool life of one minute.

**Tool Life and Wear:**
The tool life is an important factor in a cutting tool performance since considerable time is lost whenever tool is ground and re-set.

A tool cannot cut for an unlimited period of time. It has its definite life. If a cutting tool is to have a long life it is essential that the face of the tool be as smooth as possible. Tool life is the time a tool will operate satisfactorily until it is dulled. A blunt tool causes chatter in machining, poor surface finish, increase in cutting forces and power consumption, overheating of the tool.

**Advantages of Carbon Composites:**
Carbon fiber composites are extremely versatile. Vermont Composite's engineering team has the tools and experience to develop the optimal properties required for almost any application.

The properties of a carbon fiber composite structure depend on the selection of the components and how they are arranged. The two principal elements of a carbon composite structure are the matrix and the fibers.

Fiber can be individual strands or multiple strands braided. The selection of the fiber, its orientation and its layering play a dominant role in determining the characteristics of the finished structure. Certain ingredients may be added to the matrix during production that will provide additional desired properties. The following points highlight the principal advantages and characteristics of carbon fiber composites

**MATERIALS AND METHODS:**
The most important advantage associated with composites is their high strength and stiffness along with low weight. This high strength to weight ratio enables the greater usage of composites in space applications where being light and strong is given prime importance. Also, in composites the fibers present share the load applied and prevents the rapid propagation of cracks as in metals. Another advantage of composites is the flexibility associated with their designing method. It is because they can be moulded to form various shapes be it easy or complex.

**RESULTS:**
Composites with proper composition and manufacturing can withstand corrosive and high temperature environments. With all these advantages it is obvious to think why the composites have not replaced the metals. One major drawback linked with the composites is its high cost which is often due to the use of expensive raw materials and not due to the manufacturing processes.

**CONCLUSIONS:**
Structural materials used in a machine tool have a decisive role in determining the productivity and accuracy of the part manufactured in it. Here in the project the conventional material (Cast iron, Stainless steel) is replaced by using the composite materials (Carbon Fiber Reinforced Polymer and Oil palm).

Computer aided engineering has preferred for various design stage for developed the 3D cad model so here the cad model of machine tool is developed by using SOLID WORKS 2013.

This work has been developed using ANSYS, a finite element package which contains a pre-processor, a number of solvers and a post-processor. In case 1 50% of oil palm material with carbon fiber reinforced polymer (CFBR) is efficient for total deformation and mode frequency range when compare to conventional material, so we are selecting CFRP. Further CFRP is analyzed with different percentage (25%, 75%) of oil palm material inserting with length 30mm & 90mm respectively. When Comparisons of results for 25%and 75% of oil palm material with CFRP, the efficient result had been found only by using 75% of oil palm material with CFRP. Hence 75% Oil palm with CFRP material which possesses good damping and stiffness has to be developed as structural materials.

**REFERENCES:**
1. DaiGilLee, Jung Do Suh, Hak Sung Kim, Jong Min Kim, 2004, "Design and manufacture of composite high speed machine tool structures" Composites Science and Technology, Korea advanced institute of science and technology,ME 3261, Daejecon,Repablic of Korea,Volume 64,December 2004, pages 1523–1530.
2. Nora'asheerabintimohdnazifin their paper "Composites from polypropylene (PP) reinforced with oil palm empty fruit bunch (OPEFB) fibre" in May 2011,Korea advanced institute of science and technology, ME 3221, Daejecon,Repabilc of Korea
3. Byoung Jung Kim, Hak Sung Kim, Dai Gil Lee in their paper "Design of hybrid steel/composite circular plate cutting tool structures" in9 June 2006,Faculty of Chemical Engineering and Natural Resources Engineering, University of Malaysia Pahang, Malaysia.
4. Kim N. H., Won D., and ZiegertJ. C."Numerical analysis and parameter study of a mechanical damper for use in long slender endmills" Int. J. of Machine Tools & Manufacture Volume 46 2006, pages 500–507,Departement of Mechanical and Aerospace Engineering, University of Florida,USA.
5. Daghini L., Archenti A., and Nicolescu C. M. "Design, Implementation and Analysis of Composite Material Dampers for Turning Operations" Proceedings of world academy of science, engineering and technology, Volume 41, May 2009, ISSN: 2070-3740, Sweden.